# Initial Considerations for EIC detector EMCal

## (from the viewpoint of data analyzer )

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EIC-YR-Detector-Calorimetry Meeting

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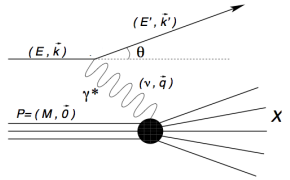
# EMCal at EIC

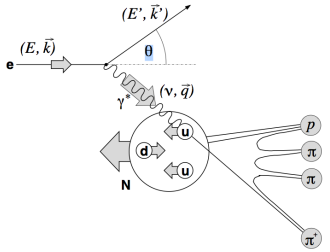
## Electron/photon PID, energy, position:

### Coverage, resolutions, granularity, projectivity

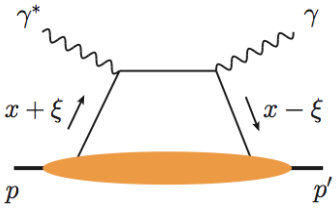
Inclusive DIS: scattered electron



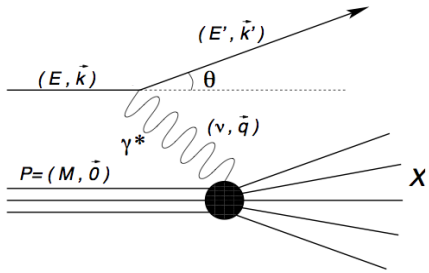

Semi-Inclusive DIS: $\pi 0$

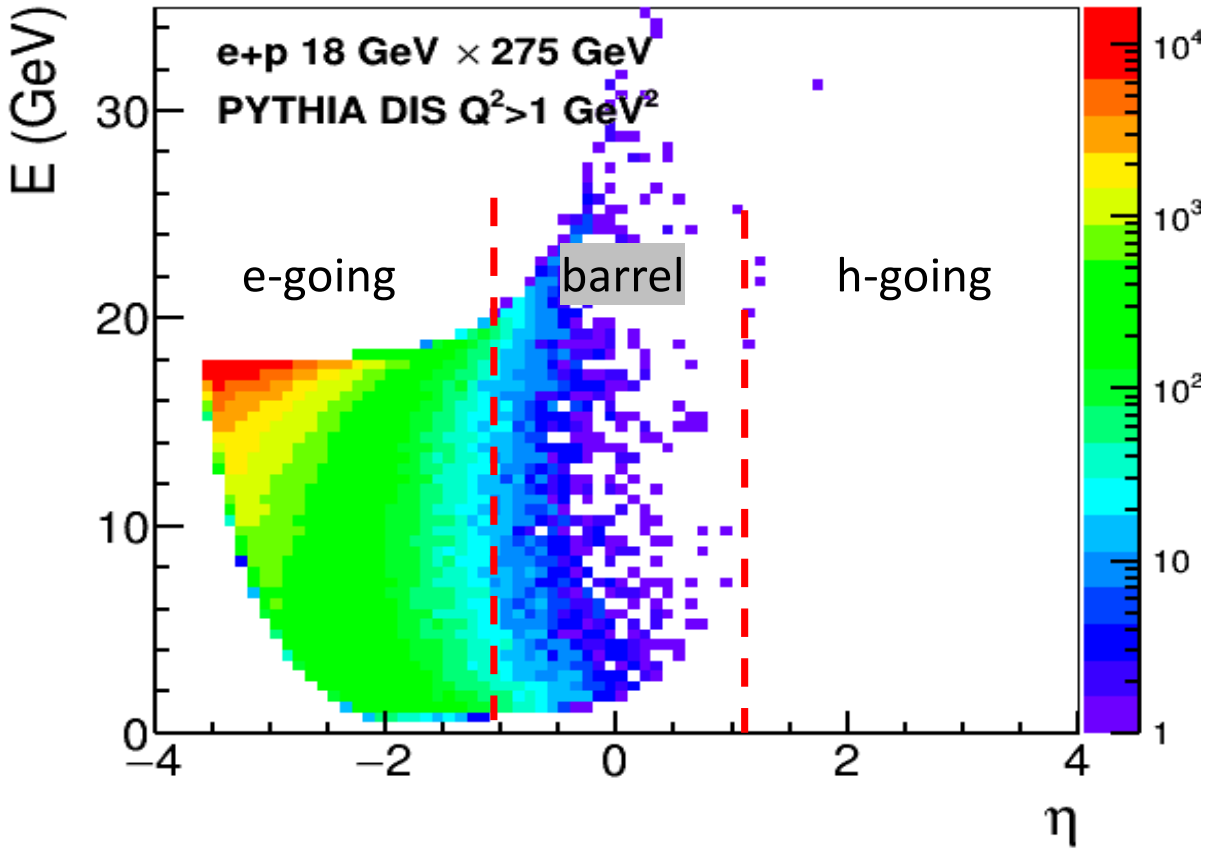



Exclusive DIS: DVCS photons, J/ψ→ee etc.



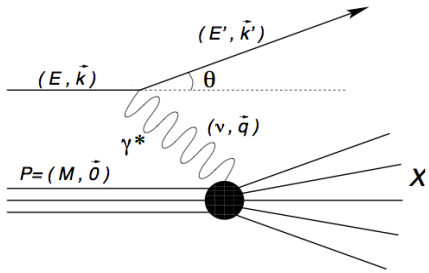
# Inclusive DIS: scattered electron



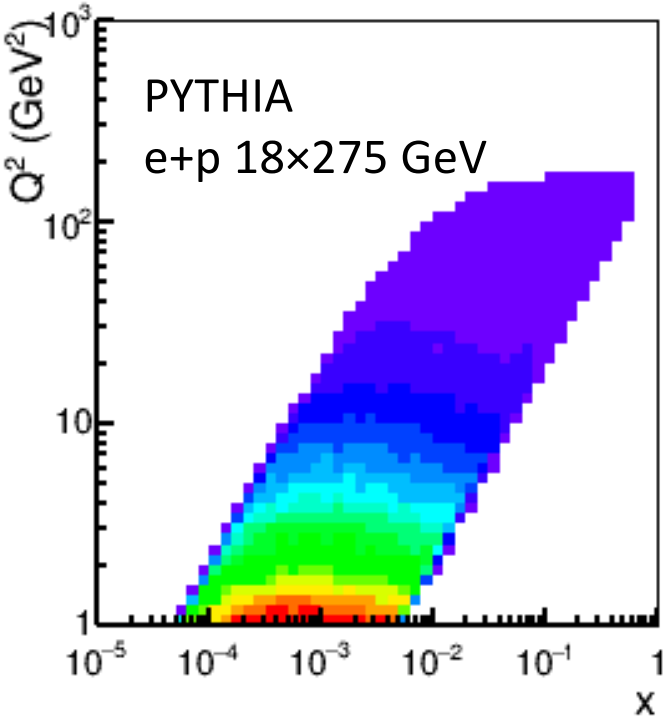




Mostly scattered in backward (e-going) and barrel
Electron energy varies from 0 to e-beam energy in backward (e-going),
And to higher energy in barrel and h-going region

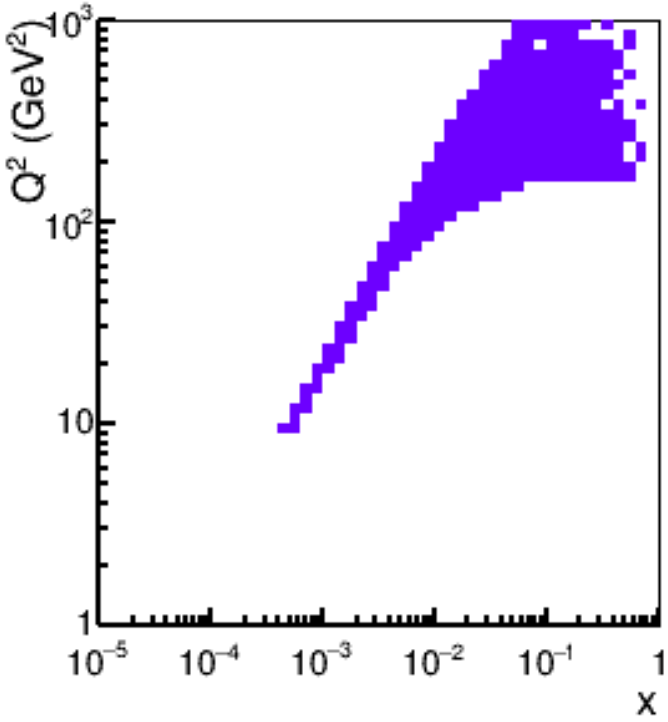
# Inclusive DIS: $Q^2$ vs x




η<-1 (e-going)

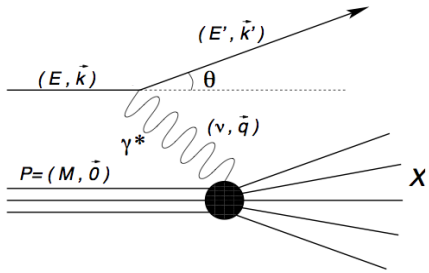


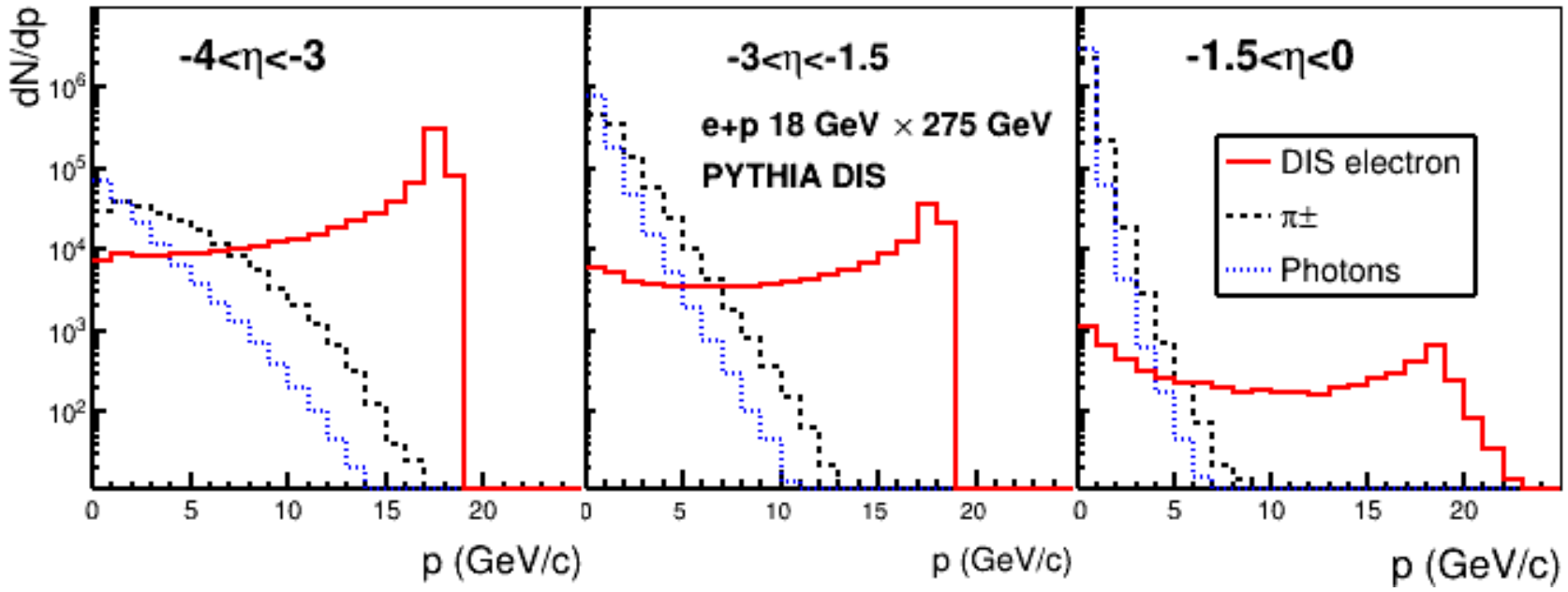

|η|<1 (barrel)




High $Q^2$ events correspond to scattering in barrel (and h-going) region

# Inclusive DIS: background



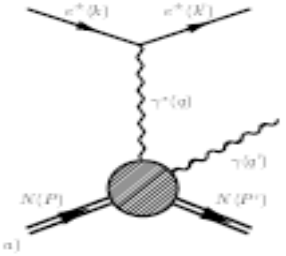




Clean measurements at higher momenta

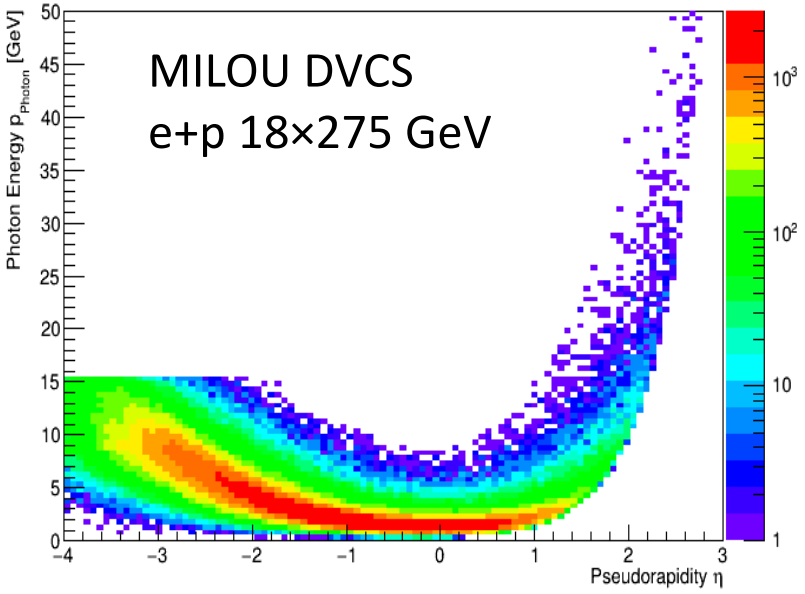
Huge background at lower momenta

Down to what momenta should we provide reliable ePID?

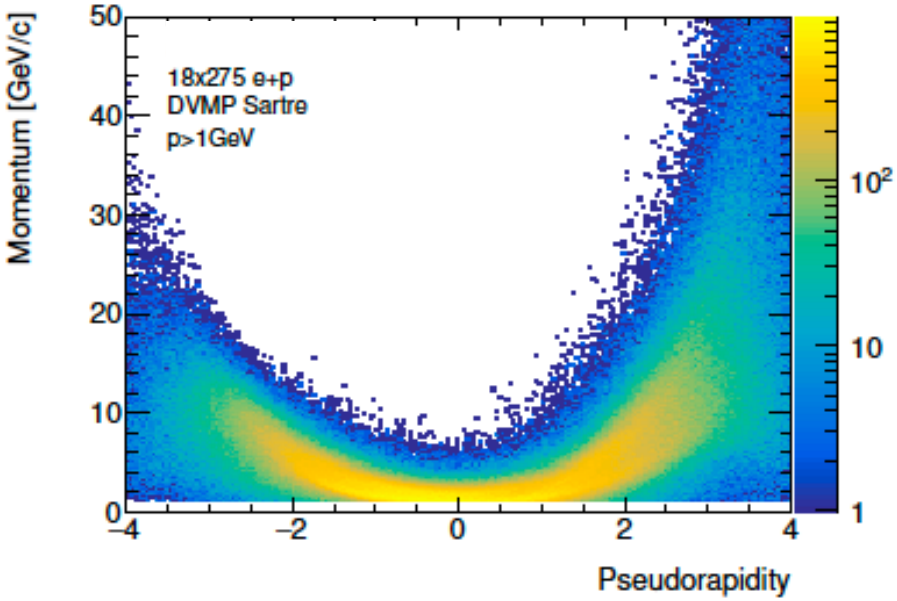
# Exclusive DIS: DVCS and DVMP



DVCS photon kinematics



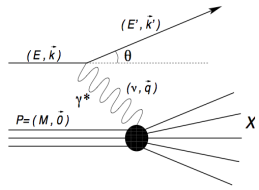

J/ψ→ee kinematics




Wide rapidity coverage is crucial

# Resolutions

$$Q^2 = 4EE'\sin^2\left(\frac{\theta}{2}\right) \qquad y = 1 - \frac{E'}{E}\cos^2\left(\frac{\theta}{2}\right) \qquad x = \frac{Q^2}{sy}$$



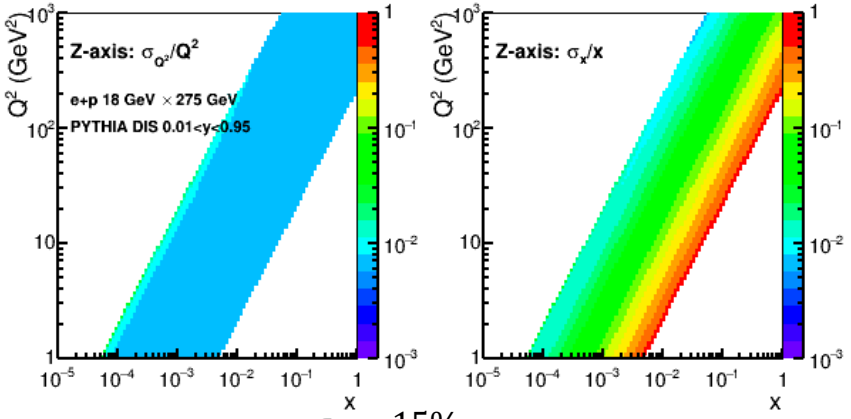

## Resolutions for (x,$Q^2$)

For perfect angle measurements:

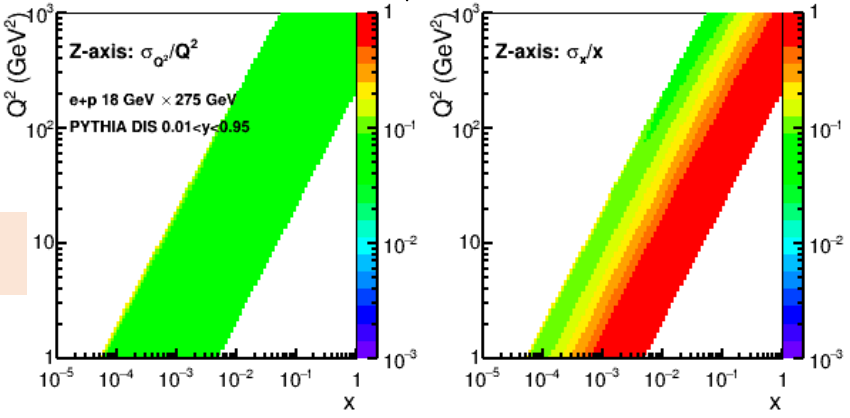
$$\frac{\sigma_{Q^2}}{Q^2} = \frac{\sigma_{E'}}{E'} \qquad \frac{\sigma_x}{x} = \frac{1}{y}\frac{\sigma_{E'}}{E'}$$

Defines the precision of unfolding technique to correct for smearing due to detector effects
Minimal effect from position resolution

$$\frac{\sigma_E}{E} = \frac{1.5\%}{\sqrt{E}} \oplus 0.5\%$$




$$\frac{\sigma_E}{E} = \frac{15\%}{\sqrt{E}} \oplus 2\%$$




Better resolution => wider kin. coverage in x

Good resolution is particularly important in backward (e-going) direction:

- Due to a general degradation of tracking performance close to the beam line
- Higher $Q^2$ kinematics (in barrel and h-going direction) can be extracted from final state hadron measurements (Jacquet-Blondel approach)

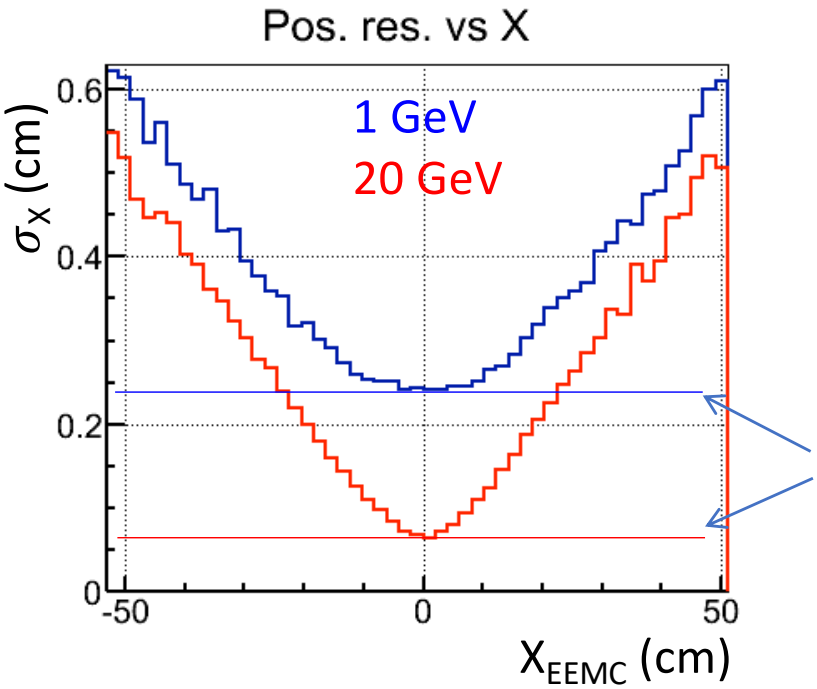
# Projectivity

Non-projectivity:

Deteriorates position resolution

Deteriorates shower profile evaluation (for e/**γ** identification and $\pi^0$/**γ** discrimination)

GEANT4: Crystal endcap EMCal at ~1.2m




*For projective geometry*

$$\sigma_X(E,\theta_X) = \sigma_X(E,0^0) \oplus d\sin(\theta_X)$$

For projective geometry

"Non-projectivity" term (from long. shower fluct.) d~$X_0$

Position resolution is dominated by "non-projectivity" term (for this non-projective EMCal)

# Granularity and $\pi 0/\boldsymbol{\gamma}$ discrimination in EMCal (alone)

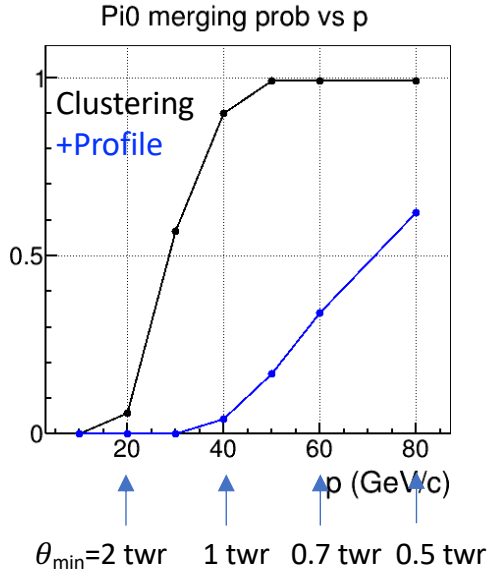
$$\theta_{min}^{\pi 0 \to \gamma\gamma} \approx \frac{2m_{\pi 0}}{E_{\pi 0}}$$

## $\pi 0 \to \boldsymbol{\gamma\gamma}$ :

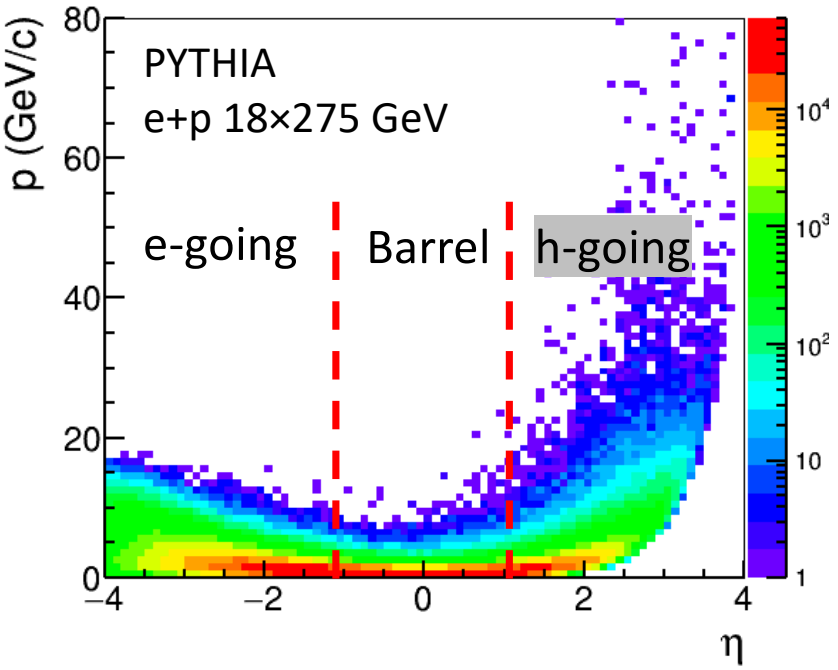
"Simple" clustering distinguishes two photons if they are separated by 1.5–2 tower distance in EMCal

Shower profile analysis distinguishes merged photons from single one if they are separated by 0.5–1 towers.

GEANT4:
Forward EMCal with granularity ~0.007 ($2\times2$ cm$^2$ at z=3m)




Pion: p vs $\eta$




Pion momenta are limited by ~10 (~15) GeV/c in barrel (e-going) => Granularity of 0.03 (0.02) looks sufficient

<0.01 granularity may be needed for h-going